



SUBSTITUTE SPECIFICATION: MARKED-UP VERSION

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U.S. Application No. 10/519,172

CIRCUIT ARRANGEMENT FOR A MOBILE TELEPHONE

TECHNICAL FIELD

5 The invention relates to This patent application describes a circuit arrangement for a mobile telephone with an antenna, an antenna line and signal lines. In addition, the circuit arrangement contains band-pass filters and amplifiers.

BACKGROUND

10 Circuit arrangements ~~of the type noted above~~ are ~~known and are~~ used for the transmission branch of a mobile telephone. The frequency range used in the transmission branch forms the so-called full band. Such a full band can range, for example, from 1.85 to 1.91 GHz. The full band is divided into two half-bands, the lower half-band ranging from 1.85 to 1.88 and the upper half-band from 1.88 to 1.91 GHz. To use the two half-bands, two signal lines are provided in the transmission branch. Signals processed in the two signal lines by ~~OFW SAW~~ filters, for example, reach an amplifier shared by the two signal lines through a reversing switch that switches between the two signal lines. From there, they are fed to a band-pass filter that separates the amplifier from an antenna connected downstream from the band-pass filter outside the frequency band used for transmission, using a type of locking attenuation.

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A drawback of the ~~known circuit arrangement prior art~~ is that both half-bands of the transmission branch proceed to the antenna through the same band-pass filter. However, the band-pass filters that are typically used have an attenuation curve that is not optimal across the entire full band. Instead, the characteristic in the upper range of the full band gradually merges into the flank, leading to an increase in the insertion attenuation of up to 3.5 dB at the upper edge of the full band. Accordingly, this results in the disadvantage that the high attenuation at the edge of the full band must be offset by an amplifier provided with a correspondingly higher level of power. Such an amplifier is associated with elevated power consumption, which normally reduces the operating time of mobile telephones operated by batteries ~~in a disadvantageous manner.~~

SUMMARY

It is the goal of the present invention to provide a circuit arrangement in which the power consumption in the transmission branch is reduced.

This goal is achieved, according to the invention, by means of a circuit arrangement according to claim 1. Advantageous further developments of the invention are found in the additional claims.

The invention relates to This patent application describes a circuit arrangement for a mobile telephone having a transmission branch. A first signal line for a first frequency band and at least one other signal line for at least one other frequency are provided in the

transmission branch. In addition, an antenna line is provided that is connected to an antenna. The antenna is connected to a switch for optional contact of the antenna to one of the signal lines. An amplifier is connected in series with each signal line. A band-pass filter for the corresponding frequency band is connected between each amplifier and the switch.

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The circuit arrangement has the advantage that, for each signal line, there is a dedicated band-pass filter that can be optimized with respect to attenuation on this band, which means that very little loss occurs in the band-pass filter. It is preferable that The corresponding reception band, in each instance, may be located correspondingly at a greater distance on the frequency band. This in turn means that the amplifier can be designed to be relatively weak, which results in a reduction in the power consumption of the amplifier and, at the same time, an advantageous increase in the operating time of the mobile telephone.

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In addition, a reception branch that contains an additional signal line for an additional frequency band is provided in one embodiment of the circuit arrangement. A band-pass filter for the additional frequency band is connected in a series to the signal line. The reception branch and the transmission branch of the circuit arrangement can be connected to the antenna line via a circulator by means of a insulator.

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It is advantageous if the band-pass filters of the circuit arrangement are designed as ceramic filters. Such ceramic filters may be implemented are realized, for example, as ceramic bodies provided with holes. The filter function is achieved with coupled, short circuit lines shielded by an external metal coating. However, the band-pass filters can 5 also be designed in the form of OEW SAW filters.

To design the circuit arrangement in a compact manner, it is advantageous to connect several ceramic filters using a shared piece of sheet metal, the sheet metal being located above the ceramic filters. The shared piece of sheet metal can also serve as a 10 shared connection for grounding.

Furthermore, it is advantageous to connect passive components for adjustment of the impedances between the switch and the band-pass filters in each signal line. Such passive components can, for example, be n-filters II-filters or a cable. The losses of the 15 circuit arrangement can be reduced further by means of such passive components for impedance adjustment. Furthermore, depending on the filter characteristics, it can be advantageous if a passive component for impedance adjustment is connected between the insulator an isolator and the band-pass filter in the reception branch.

20 To reduce the space requirements of the circuit arrangement, as well as to design the circuit arrangement in a compact manner, it is advantageous if the insulator isolator and the passive components are integrated into a multilayer substrate. In addition, the

switch can be mounted on the upper side of the multilayer substrate. Such multilayer substrates are known, for example, under the name "LTCC module = Low Temperature Cofired Ceramic module." Such LTCC modules can be manufactured to be space saving and contain a plurality of various passive components and active components.

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To effectively reduce the energy consumption of the amplifier, it is advantageous if the amplification P_{out}/P_{in} of the amplifiers of the circuit arrangement is less than 26 dB.

It is also advantageous if the band-pass filters are specifically matched to the corresponding frequency range. This can be achieved, for example, by using the filter curve of a band-pass filter, which is essentially suitable for filtering the full band but already has a high attenuation at the high-frequency end of the full band, as the basis for the band-pass filters in the circuit arrangement. As an example, the band-pass filter for the full band can also be used for the lower half-band. By shifting the attenuation curve of the band-pass filter, which is easily achieved by shortening the component (ceramic body) as well as by subsequent optimization, the attenuation curve can be matched to the upper half-band. This results in minimal attenuation occurring in the band passes for both half-bands.

As a result of the use of identical attenuation curves that can only be brought into approximate alignment by shifting them along the frequency curves, it is not necessary to develop a new band-pass filter to bring about the circuit arrangement. Instead, a known

band-pass filter that is essentially suitable for filtering the full band can be used in an advantageous manner.

In the following, the invention circuit arrangement is explained in greater detail on 5 the basis of exemplary embodiments and the corresponding figures.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a circuit arrangement in a schematic depiction.

Figure 2 shows attenuation curves of band-pass filters, such as those that can be 10 used in the circuit arrangement depicted in Figure 1.

DETAILED DESCRIPTION

Figure 1 shows a circuit arrangement for a mobile telephone. A transmission branch 11 and a reception branch 12 are provided. The reception branch 12 leads to a low-noise amplifier. The reception branch 12 (not shown in Figure 1) is connected to a chip set, which modulates the wanted signals and upwardly mixes them into the respective frequency range of the transmission branch. The transmission branch 11 comprises 15 includes two signal lines 21, 22, whereas the reception branch 12 comprises includes only one signal line 23. The signals coming from a chip set and running through the signal lines 21, 22 are processed in surface acoustic wave (SAW) filters 201, 202. Each signal subsequently reaches an amplifier 61, 62 that amplifies the voice signals in such a way 20 that they are suitable for transmission of the signals. To separate the amplifiers 61, 62

from the antenna 4 of the circuit arrangement, band-pass filters 71, 72 are provided, each of which is separately adjusted for a signal line 21, 22. The insertion attenuation of the band-pass filters 71, 72 can be advantageously reduced in that for each signal line 21, 22 that is operated on a corresponding half-band, there is a dedicated amplifier 61, 62 as well as a dedicated band-pass filter 71, 72, so that the amplifiers 61, 62 can be designed for lower output. As a result, both the energy consumption of the circuit arrangement and the space requirements are reduced. Amplifiers 61, 62 designed for lower output require less space than an amplifier designed for higher output. The transmission branch 11 is also connected to an LTCC module 100 that is, with a multilayer substrate with a switch 5, for example, integrated into its upper side. Integrated into the multilayer substrate is a switch 5, which connects the antenna line connected to the antenna 4 with either the signal line 21 or the signal line 22. Passive components 91, 92, which are integrated into the module 100, are provided for adjustment of the impedances between the switch 5 and the band-pass filters 71, 72. These passive components 91, 92 can be, for example, ~~n~~-filters II-filters or a cable. The switch 5 can be a GaAs field effect transistor, for example. However, it can also consist of include PIN diodes. Furthermore, it is also possible to build the switch 5 with micromechanics components, which, for the system envisioned here, would offer the very important advantage of good linearity and the advantage of reduced losses.

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In addition, an insulator isolator 8 can be provided, which can be integrated into the module 100 through the use of ferrite materials. The purpose of the insulator isolator

8 is to separate the transmission branch 11 from the reception branch 12. A band-pass filter 73, in turn, is connected in the signal line 23 of the reception branch 12 and is connected to the ~~insulator~~ isolator 8 through a passive component 93. The position of the ~~insulator~~ isolator is variable and is not limited to the depiction in Figure 1. In one 5 embodiment a variant of the invention, the ~~insulator~~ isolator can also be disposed outside the multilayer module 100.

It can also be provided that a ~~duplexer~~ diplexer is integrated into the multilayer module 100, ~~said duplexer~~ the diplexer —as seen from the antenna—causing a split into 10 the frequency range of the transmission branch and a frequency range at a lower position. This means that the antenna line constitutes a connection to the ~~duplexer~~ diplexer within the multilayer module.

The frequency band used in the transmission branch 11, which is also referred to 15 as a full band, can range, for example, from 1.85 to 1.91 GHz. This full band is divided into two half-bands. In this arrangement, the first half-band is the frequency range fB1, which is shown in Figure 2 and ranges from 1.85 GHz to 1.88 GHz. A band-pass filter having the filter curve identified by K1 in Figure 2 can be used for the first frequency 20 range fB1, which is linked to the signal line 21. The filter curve K1 is characterized by a very low attenuation in the frequency range fB1. If the filter in Figure 2 characterized by the filter curve K1 were used for band-pass filtering in the full band, an already significant attenuation of about 3.5 dB at the right band edge at 1.91 GHz would exist for the second

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half-band, which encompasses the frequency range f_{B2} , which, in turn, according to Figure 2, ranges from 1.88 to 1.91 GHz. Accordingly, it is advantageous, according to Figure 2, to provide the filter 72 with the filter curve K2, which is shifted to the right along the frequency axis by 0.03 GHz relative to the filter curve K1.

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Figure 2 shows filter curves, in which the amplification D of the filter, measured in dB, is plotted against the frequency, measured in GHz.

1. A circuit arrangement for a mobile telephone having a transmission branch (11), comprising

- a first signal line (21) for a first frequency band (fB1) and at least one other

5 signal line (22) for at least one other frequency band (fB2),

- an antenna line (3), which is connected to an antenna (4),

- in which the antenna line is connected to a switch (5) for optionally contacting the antenna (4) with one of the signal lines (21, 22),

- and in which an amplifier (61, 62) is connected in series with each signal line

10 (21, 22),

- in which a band-pass filter (71, 72) for the respective frequency range (fB1, fB2)

is connected between each amplifier (61, 62) and the switch (5).

2. A circuit arrangement as claimed in claim 1, having a reception branch (12),

15 - containing an additional signal line (23) for an additional frequency band,

- in which a band-pass filter (73) for the additional frequency band is connected in

series to the signal line (23),

- and in which the reception branch (12) and the transmission branch (11) of the

20 circuit arrangement are connected to the antenna line (3) by means of an insulator (8).

3. A circuit arrangement as claimed in one of claims 1 or 2,

in which a band-pass filter (71, 72, 73) is designed as a ceramic filter.

4. A circuit arrangement as claimed in claim 3,

in which several ceramic filters are mounted on a shared piece of sheet metal.

5 5. A circuit arrangement as claimed in claim 1,

in which passive components (91, 92) for impedance adjustment are connected between the switch (5) and the respective band-pass filters (71, 72).

6. A circuit arrangement as claimed in claim 2,

in which a passive component (93) for impedance adjustment is connected between the insulator (8) and the band-pass filter (73) in the reception branch (12).

7. A circuit arrangement as claimed in one of claims 2 to 6,

in which the insulator (8), the switch (5) and the passive components (91, 92, 93) are integrated into a multilayer module (100).

8. A circuit arrangement as claimed in one of claims 1 to 7,

in which the band-pass filters (71, 72) have attenuation curves (K1, K2) that can be brought into approximate alignment by shifting them along the frequency axis.

20 9. A circuit arrangement as claimed in one of claims 1 to 8,

in which the amplification of the amplifiers (61, 62) is less than 26 dB.

ABSTRACT

CIRCUIT ARRANGEMENT FOR A MOBILE TELEPHONE

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A circuit arrangement for use with a mobile telephone includes a transmitting circuit. The transmitting circuit includes a first signal line that corresponds to a first frequency band, a second signal line that corresponds to a second frequency band, a switch that connects an antenna to one of the first and second signal lines, a first amplifier in series with the first signal line, and a second amplifier in series with the second signal line. A first band-pass filter is between the first amplifier and the switch. The first band-pass filter has a frequency range that corresponds to the first frequency band. A second band-pass filter is between the second amplifier and the switch. The second band-pass filter has a frequency range that corresponds to the second frequency band.

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